

### **REMARKS**

In the office action, the Examiner again rejected claims 1, 2, 4-9, 11-13, 15-17, 19, 22-25, and 28 pursuant to 35 U.S.C. §102(e) as being anticipated by Skyba, et al. (U.S. Patent No. 6,692,438). Claims 3, 18, 20, 21, 26, 27, and 29-31 were again rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Hossack, et al. (U.S. Patent No. 6,755,787). Claims 20, 21, 30 and 31 were rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Sumanaweera, et al. (U.S. Patent No. 6,443,894). Claims 10, and 14 were again rejected pursuant to 35 U.S.C. §103(a) as being unpatentable over Skyba, et al. in view of Chiang, et al. (U.S. Patent No. 6,969,352).

Applicants respectfully request reconsideration of the rejections of claims 1-31, including independent claims 1, 16, 17, and 28.

Independent claim 1 recites identifying a phase of a cyclically varying imaging parameter relative to a physiological cycle for each of a plurality of spatial locations in each of a plurality of image frames, and highlighting spatial locations in a first image of the plurality of images associated with a first phase and spatial locations in a second image of the plurality of images associated with a second phase, the second phase different than the first phase and the second image corresponding to the different time than the first image.

Skyba, et al. do not disclose identifying a phase of a cyclically varying imaging parameter relative to a physiological cycle for each of a plurality of spatial locations in each of a plurality of image frames. First, Skyba, et al. do not identify a phase for spatial locations in each image. Skyba, et al. acquire images from different phases of the heart cycle (col. 4, line 65-col. 5, line 1). Different images are triggered based on the heart cycle (col. 5, lines 21-38) or may be acquired continuously (col. 5, line 21). Skyba, et al. identify the phase of the heart cycle associated with each image, such as image one being at the R wave and image 2 being at the Q wave (see Figure 5). Skyba, et al. do not identify a phase for spatial locations in each image.

Once a group of images with a same phase is formed, the perfusion curve for each spatial location is determined (col. 6, lines 20-44). Since the images in the group all have a

same phase relative to the heart cycle, motion of the heart is not a factor. Instead, the perfusion steady state (A) and rate of change (B) are determined for each spatial location. Skyba, et al. do not identify a phase for spatial locations in each image.

Second, Skyba, et al. identify the phase based on the ECG, not a cyclically varying imaging parameter. ECG is an electrical input signal, not an imaging parameter. The Examiner alleges the perfusion/reperfusion as a "valid cyclically varying imaging parameter as reperfusion will directly affect the images obtained during imaging" (Office Action dated Aug. 8, 2007, page 2). However, perfusion increases to and holds at a steady state. Skyba, et al. shows such exponential curve at 110 in Figure 12. The intensity is represented by the y-axis, and the x-axis is the frame number or heart cycle number. As shown, the curve 110 does not vary cyclically.

Any perfusion, followed by reperfusion also does not provide a cyclically varying imaging parameter. Skyba, et al. provide for an initial high intensity or MI pulses to destroy any perfused contrast agent (col. 5, lines 7-13). Subsequently, low intensity or MI pulses are used for imaging (col. 5, lines 13-17). At most, this provides for initial perfusion, followed by destruction, and then perfusion for imaging and analysis. This provides a "U" or "V" shape curve of intensity as a function of heart cycle or frame. This pattern does not provide cyclical variation. Skyba, et al. do not identify a phase of a cyclically varying imaging parameter.

Third, to image the perfusion, cyclical variation is removed by Skyba, et al. by grouping the images associated with a same phase of the heart cycle. Heart movement results in heart tissue being at different locations relative to a scanned region at different times in the heart cycle. For a given image spatial location, the data may be for perfused heart tissue in one frame, but contrast filled fluid in another frame. To avoid incorrectly determining perfusion, images at a same ECG wave are grouped. The same spatial locations in images from a same ECG wave are likely to be associated with the same scanned tissue. The perfusion of tissue from no contrast agent to the steady state as a function of time over several heart cycles may be determined without artifacts caused by heart motion. Skyba, et al. seek to remove cyclically varying information by grouping images from a same ECG wave, and then determine perfusion by exponential curve matching at each spatial location

within the group. A sequence of such parametric images associated with different phases of the heart cycle may be generated (col. 6, line 60-col. 7, line 12). However, Skyba, et al. do not determine any relative phase, so do not disclose identifying a phase of a cyclically varying imaging parameter relative to a physiological cycle for each of a plurality of spatial locations in each of a plurality of image frames.

Independent claim 16 recites identifying a phase of a cyclically varying imaging parameter relative to a heart cycle for each of a plurality of spatial locations in each of a plurality of image frames. Accordingly, claim 16 is allowable for the same reasons as claim 1.

Independent claim 17 recites matching a sinusoid waveform with the ultrasound data for each of the pluralities of spatial locations. Skyba, et al. match an exponential representing perfusion of contrast agents, not a sinusoid waveform.

The Examiner cites to matching "the B-mode data up with ECG data, which is a sinusoidal variation throughout a heart cycle" (Office Action dated Aug. 8, 2007). However, Skyba, et al. do not match the ECG with the ultrasound data for each of the spatial locations. Instead, the ECG data is used to trigger or mark each image. Each image is labeled as occurring at a particular time in the ECG heart cycle. The ECG waveform is not matched with data for each spatial location.

Claim 17 also recites isolating information associated with at least one frequency band from information associated with a different frequency band for each of the plurality of spatial locations as a function of the matched sinusoid. The Examiner cites to col. 3, lines 10-65 of Skyba, et al. A desired transmit frequency band is used (col. 3, lines 20-25 and 38-42). The transmit activation may be synchronized with the heart cycle waveform provided by the ECG device (col. 3, lines 25-33). For receiving echoes, a filter filters the received signals (col. 3, lines 54-65). The filtering is to isolate information at a desired band, such as at the transmit band or a harmonic band. Skyba, et al. transmit at one band (e.g., 2 MHz center frequency), and receive the echo signals. The received signals are filtered at the same or different band (e.g., 2 or 4 MHz center frequency) to remove noise or other undesired

information. This typical ultrasound filtering is not filtering as a function of a matched sinusoid. The ECG is used merely to activate the transmitter. The frequency of the heart cycle waveform is not used for the filtering.

Independent claim 28 recites matching a sinusoid waveform with the ultrasound data for each of the pluralities of spatial locations, and isolating information associated at least one frequency band from information associated with a different frequency band for each of the plurality of spatial locations as a function of the matched sinusoid. As discussed above for claim 17, Skyba, et al do not disclose these limitations.

Dependent claims 2-15, 18-27, and 29-31 depend from the independent claims so are allowable for the same reasons as the corresponding base claim. Further limitations patentably distinguish from the cited references.

Claim 2 recites matching a sinusoid, and identifying a phase of the sinusoid relative to the time within the physiological cycle. Skyba, et al. use ECG information to select images for a heart cycle phase. The images are then used to match an exponential curve to the data. Skyba, et al. do not match a sinusoid, and do not identify a phase of the sinusoid relative to the time within the physiological cycle.

Claim 4 recites identifying the phase for single pixels. Skyba, et al. uses heart cycle phase for images, not single pixels. Skyba, et al. match the exponential using nine pixels for each image (col. 6, lines 21-24), not single pixels. As noted by the Examiner, Skyba, et al. determine mean pixel values over time for a given phase of the heart cycle. However, the phase is based on the entire image, so is not identified for single pixels.

Claim 6 recites highlighting by setting the imaging parameter to a darker shade for spatial locations associated with the different phases. Skyba, et al. creates a parameter image, but does not suggest darker regions for spatial locations associated with a particular phase. The Examiner cites to col. 7, lines 12-37. Skyba, et al. mention "light up" of the tumor. This light up is common for contrast agent imaging, where contrast agents have a stronger return than tissue. Perfused tissue appears brighter. However, this lighting up is

independent of the phase and is not setting the cyclically varying imaging parameter to a darker shade, but instead showing contrast agent as brighter regardless of phase.

Claim 11 recites highlighting of one image associated with a first phase and free of highlighting for the second phase. Skyba, et al. generate a parameter image for each phase of the heart cycle. The parameter is used to create the image. Skyba, et al. does not disclose highlighting an already existing image. Each parametric image of Skyba, et al. is associated with a different phase. However, highlighting is not provided in any of the images. Instead, the perfusion curve provides the display values for each pixel without highlighting data at one phase relative to another phase.

Claim 23 recites generating images of intensities as a function of time responsive to adding information from a different frequency band to isolated information. Skyba, et al. generate images of intensities as a function of time to represent perfusion. The images are not generated responsive to adding information from a different frequency band to isolated information. Skyba, et al. provided received signals at a frequency band. There is no teaching to add information from different bands and generate an image.

Claim 25 recites addition in the frequency domain. Skyba, et al. does not show the addition, and does not show any functions in the frequency domain. Skyba, et al. shows time domain digital filtering, not performing operations in the frequency domain.

Claims 3, 18, 20, 21, 26, 27, and 29-31 are allowable since a person of ordinary skill in the art would not have used the Fourier transform in Skyba, et al., especially as taught by Hossack, et al. Skyba, et al. use ECG signals to label the heart cycle phase associated with each image. There is no cyclical or frequency processing. Filtering is performed using transmit and receive techniques or FIR filtering. There is nothing in Skyba, et al. to suggest frequency domain processing and the corresponding use of a Fourier transform. Hossack, et al. teach Fourier transform for data compression. Data compression is unrelated to the teachings of Skyba, et al.

The Examiner alleges that once Fourier transform is performed, it is inherent that phase angle data and fundamental frequency would be known. However, Fourier transforms may be used for other purposes. Accordingly, phase angle data and fundamental frequency

are not inherent. Regardless, there is no suggestion to use a Fourier transform in Skyba, et al.

As noted, frequency domain filtering in general is known. Hossack, et al. show one implementation of frequency domain filtering – data compression. However, a person of ordinary skill in the art would not have used frequency domain techniques in the teachings of Skyba, et al. Time domain filtering is used for real-time imaging due to the lesser processing requirements. The pulse inversion at col. 4, lines 5-17 requires transmitting acoustic energy with different polarity pulses and adding the resulting echo signals. Transmission cannot be done in the frequency domain. Simple addition of the receive signals would not be done in the frequency domain. Skyba, et al. are familiar with the response frequency of contrast agents. This in no way suggests processing in the frequency domain.

Claims 3 and 18 recite matching a sinusoid by performing a Fourier transform. Hossack, et al. use the transform for compression, not matching a sinusoid.

Claim 20 recites isolating information associated with an unvarying component and a fundamental frequency component by reducing values for information associated with second harmonics. This isolation is a function of the matched sinusoid. Skyba, et al. use pulse inversion to identify received signals with a harmonic response. This does not provide for isolating as a function of a matched sinusoid.

Claim 21 is allowable for a similar reason as claim 20.

Claims 27 and 29 recite transforming, isolating and inverse transforming the isolated information. Hossack, et al. teaches transforming an image while avoiding loss. Compression uses the relationship between pixels. There is no suggestion to transform data for a spatial location, and isolating frequency information associated with the spatial location.

Claim 31 recites detecting a boundary from phase data. Skyba, et al. detects a boundary from image data, not phase data. Sumanaweera, et al. use Doppler data, gradient data, marching cubes, tetrahedral tessellation, and tracing, but do not disclose using phase data. Harmonic data is data responding to a transmit acoustic beam at a harmonic frequency. Harmonic data is not phase data.

Claim 10 recites displaying and highlighting images where highlighting is of movement of a mechanical heart wave contraction wave. Chiang, et al. merely note use of an imaging device for pacemaker monitoring or cardiac rhythm management. There is no suggestion in Chiang, et al. or Skyba, et al. to highlight an image for movement of a mechanical heart wave contraction. The Examiner interprets this limitation to be highlighting for a mechanical heart. A mechanical heart wave contraction is a known concept associated with actual hearts. Chiang, et al. and Skyba, et al. do not suggest the limitations of claim 10.


**CONCLUSION:**

Applicants respectfully submit that all of the pending claims are in condition for allowance and seeks early allowance thereof. If for any reason, the Examiner is unable to allow the application but believes that an interview would be helpful to resolve any issues, he is respectfully requested to call the undersigned at (650) 943-7554 or Craig Summerfield at (312) 321-4726.

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